

Semi-Annual Status Report on Grant No. NAG5-1477

RESEARCH RELATIVE TO WEATHER RADAR
MEASUREMENT TECHNIQUES

P-5

By

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This grant provides for some investigations related to weather radar measurement techniques applicable to meteorological radar systems in Thailand. Quality data are needed from those systems to support TRMM and other scientific investigations. The main activity under the grant during this period involved a visit to Thailand during the period 28 January-14 February 1992.

1. Details of Visit to Thailand

The principal investigator departed from Rapid City on 28 January 1992 and arrived in Bangkok in the early morning hours on 31 January. He and Dr. Daniel Rosenfeld of the Hebrew University of Jerusalem presented a seminar on operating strategies for meteorological radars to officials of the Thai Meteorological Department (TMD) on the morning of 3 February. The seminar was delivered to the TMD director, Mr. Pittipat, and about ten associates in a very difficult environment in the temporary quarters of the TMD. Travel to Phuket occurred on the afternoon of 3 February, and visits to the local radar site and instruction/discussion sessions took place over the period 4-12 February. The return trip to Bangkok, and a visit to the Royal Rainmaking Research and Development Institute, occurred on 13 February, and the return trip to the U.S. took place on 14 February.

2. Facilities at Phuket

The weather radar at Phuket is an Enterprise DWSR-88S S-band Doppler system installed on a hilltop a few kilometers away from the airport and the observing tower where the operator console is located. The nearby (50 m) S-band airport-surveillance-type radar with similar power output was in operation during this visit, but it appears to cause very little interference with the weather radar system.

Physical working arrangements at Phuket were much improved from the earlier visit. The classroom facility had been completed, and we were granted freer access to the innards of the radar system for calibration measurements. The printed monograph containing the basic background materials for the presentations and discussion arrived in plenty of time, except for the supplements (of which only half the needed number arrived).

3. Specific Activities and Findings

a. Group Sessions: Six formal half-day sessions with the Thai scientists, engineers and technicians were handled on a lecture/discussion basis. About 33 people were present for much of these sessions. Topics

for the sessions included radar fundamentals, radar equations, Doppler principles, Z-R relationships and rainfall measurements, and radar system calibrations. In addition, Dr. Rosenfeld conducted a similar number of sessions on topics including cloud and precipitation physics, storm structure, echo pattern interpretation and rainfall measurement. This was the second time through much of this training material for several of the participants, and the level of understanding appeared to be much enhanced this time around. The presence of three men who had recently completed M.S. programs at U.S. universities was no doubt beneficial in this regard.

b. Workshop Sessions in Radar Operations Room: We found the ANTENNA and A-SCOPE utilities in the IRIS system to function quite satisfactorily for conducting solar scans to check the orientation of the weather radar antenna. Such scans were carried out on the afternoon of 7 February and the morning of 11 February. Mr. Curt Hartzell of the U.S. Bureau of Reclamation supplied a computer program for determining the true solar azimuth and elevation angles. Results of the analysis of the solar observations showed that the antenna angle indications coming from the Phuket weather radar were in error by about $+10^\circ$ in azimuth and $+1^\circ$ in elevation. The attached table provides a synopsis of the observations leading to this conclusion. We were not successful in obtaining permission to take the necessary steps to remove the errors from the indicated angles, but hopefully this can be taken care of by local personnel.

Dr. Rosenfeld used the data playback capability on the system at Phuket to play back radar data from a small squall line which we observed during our previous visit in December 1990. The data were still resident in the computer system, and with some effort could be recalled for purposes of this demonstration. The observations illustrated several of the basic principles of echo pattern interpretation that were discussed in the group sessions.

The impression remains that the echoes visible on the PPI Doppler displays tend to be less extensive than one would expect in view of the patterns that show up in the reflectivity data. It still appears that some threshold setting in the radar system or in the software is inhibiting the presentation of weak precipitation or "clear air" echoes on the display, but we were still not able to pinpoint the source of this threshold.

c. Radar Site Activities: Visits to the radar site itself were much more productive this time. We were allowed to conduct several basic radar calibration exercises, being limited mainly by the test equipment available. (Not all of the equipment listed in the previous semi-annual status report as needed turned out to be available in the field at Phuket.) Also, we could not arrange to have the adjacent radar turned off to permit work inside the

radome of the weather radar system. Communications from the radar to the operator console were quite good.

We were able to conduct measurements of the transmitted power, and noticed that the peak power output appeared to be somewhat below the nominal value (but not enough to be of concern). No frequency meter was available for frequency determination, and the lack of a Type N barrel adapter made it impossible to check the test cables to be sure that the loss values were correct. For the linear receiver, the test indicated about a 30 dB dynamic range, which is quite reasonable. The ZAUTO utility worked quite well for calibration of the logarithmic receiver, although the system configuration was such that we could not drive it all the way to the saturation point. Apparently, this was the first time that such a calibration had been made on the system at Phuket; the operators in charge were willing to incorporate the new calibration data into their operational routine. A check of the VSWR on the antenna showed that to be satisfactory. No test equipment was available for determining the antenna gain, or for examining the duration and shape of the transmitted pulse.

d. Other Results and Comments: A crystal detector should be added to the list of needed test equipment, to permit examining the shape of the transmitted radar pulse.

STATION Phuket			LATITUDE 8° 0' 4" N		LONGITUDE 98° 19' 46" E		DATE 7 Feb 92/11 Feb		
LOCAL TIME A	GUNNER'S QUADRANT		SOLAR ELEV D	BORESIGHT ERROR E = C-D	ELEV DIAL F	EL DIAL ERROR G = F-D	AZ IND H	SOLAR AZ I	AZ OFFSET J = H-I
	B (Mile)	C (Deg)							
16:59:08 (7 Feb)			21.94		22.9	0.96	259.9	249.76	10.14
17:06:38			20.20		21.2	1.00	260.2	250.27	9.93
17:09:55			19.43		20.6	1.17	260.2	250.57	9.69
17:11:25			19.08		20.2	1.12	260.2	250.58	9.62
17:13:50			18.52		19.6	1.08	260.7	250.73	9.97
17:15:35			18.11		19.2	1.09	260.7	250.84	9.86
18:30			17.43		18.6	1.17	261.0	251.02	9.98
19:35			17.17		18.5	1.33	261.0	251.09	9.91
21:30			16.72		17.8	1.08	261.3	251.20	10.10
22:40			16.45		17.7	1.25	261.3	251.37	9.93
07:14:59 (11 Feb)			6.07		7.21	1.14	115.58	105.34	10.24
16:20			6.39		7.65	1.26	115.58	105.40	10.18
17:37			6.69		7.82	1.13	115.75	105.46	10.29
18:40			6.94		8.00	1.06	115.75	105.50	10.25
19:37			7.17		8.17	1.00	116.02	105.54	10.48
53:51			15.30		16.26	1.04	117.60	107.22	10.38
55:18			15.72		16.60	0.88	117.77	107.32	10.45
56:42			15.98		17.06	1.08	117.77	107.38	10.39
57:50			16.24		17.23	0.99	117.95	107.45	10.50
	PLUMB G.O.		SUM AVG S.D.			SUM (West) AVG 1.125 S.D. 0.11	(East) 1.064 0.11	SUM (West) AVG 9.91 S.D. 0.16	(East) 10.93 0.11